| Radionuclide | Absorption type [3] µCi/mL | | | Absorption type [3] Bq/m [3] | | | Stochastic or organ or tissue [1] |
|---|---|---|---|---|---|---|---|
| | F | M | S | F | M | S | (F/M/S) |
| Es-254m | – | 1 E−09 | – | – | 5 E+01 | – | /St/ |
| Es-254 | – | 6 E−11 | – | – | 2 E+00 | – | /BS/ |
| Fm-252 | – | 2 E−09 | – | – | 8 E+01 | – | /St/ |
| Fm-253 | – | 1 E−09 | – | – | 6 E+01 | – | /St/ |
| Fm-254 | – | 6 E−09 | – | – | 2 E+02 | – | /ET/ |
| Fm-255 | – | 2 E−09 | – | – | 8 E+01 | – | /St/ |
| Fm-257 | – | 1 E−10 | – | – | 4 E+00 | – | /St/ |
| Md-257 | – | 2 E−08 | – | – | 1 E+03 | – | /St/ |
| Md-258 | – | 1 E−10 | – | – | 4 E+00 | – | /St/ |

FOOTNOTES FOR APPENDIX A

[1] A determination of whether the DACs are controlled by stochastic (St) or deterministic (organ or tissue) dose, or if they both give the same result (E), for each absorption type, is given in this column. The key to the organ notation for deterministic dose is: BS = Bone surface, ET = Extrathoracic, K = Kidney, L = Liver, and T = Thyroid. A blank indicates that no calculations were performed for the absorption type shown.

[2] The ICRP identifies these materials as soluble or reactive gases and vapors or highly soluble or reactive gases and vapors. For tritiated water, the inhalation DAC values allow for an additional 50% absorption through the skin, as described in ICRP Publication No. 68, Dose Coefficients for Intakes of Radionuclides by Workers. For elemental tritium, the DAC values include a factor that irradiation from gas within the lungs might increase the dose by 20%.

[3] A dash indicates no values given for this data category.

[4] DAC values derived using hafnium tritide particle and are based on ''observed activity'' (i.e, only radiation emitted from the particle is considered). DAC values derived using methodology found in Radiological Control Programs for Special Tritium Compounds, DOE–HDBK–1184–2004.

[5] These values are appropriate for protection from radon combined with its short-lived decay products and are based on information given in ICRP Publication 65: Protection Against Radon-222 at Home and at Work and in DOE–STD–1121–98: Internal Dosimetry. The values given are for 100% equilibrium concentration conditions of the short-lived radon decay products with the parent. To allow for an actual measured equilibrium concentration or a demonstrated equilibrium concentration, the values given in this table should be multiplied by the ratio (100%/actual %) or (100%/demonstrated %), respectively. Alternatively, the DAC values for Rn-220 and Rn-222 may be replaced by 2.5 working level (WL) and 0.83 WL, respectively, for appropriate limiting of decay product concentrations. A WL is any combination of short-lived radon decay products, in one liter of air without regard to the degree of equilibrium, that will result in the ultimate emission of 1.3 E+05 MeV of alpha energy.

[72 FR 31927, June 8, 2007]

## APPENDIX B TO PART 835 [RESERVED]

## APPENDIX C TO PART 835—DERIVED AIR CONCENTRATION (DAC) FOR WORKERS FROM EXTERNAL EXPOSURE DURING IMMERSION IN A CLOUD OF AIRBORNE RADIOACTIVE MATERIAL

a. The data presented in appendix C are to be used for controlling occupational exposures in accordance with §835.209, identifying the need for air monitoring in accordance with §835.403 and identifying the need for posting of airborne radioactivity areas in accordance with §835.603(d).

b. The air immersion DAC values shown in this appendix are based on a stochastic dose limit of 5 rems (0.05 Sv) per year. Four columns of information are presented: (1) Radionuclide; (2) half-life in units of seconds (s), minutes (min), hours (h), days (d), or years (yr); (3) air immersion DAC in units of µCi/mL; and (4) air immersion DAC in units of Bq/m3. The data are listed by radionuclide in order of increasing atomic mass. The air immersion DACs were calculated for a continuous, nonshielded exposure via immersion in a semi-infinite cloud of airborne radioactive material. The DACs listed in this appendix may be modified to allow for submersion in a cloud of finite dimensions.

c. The DAC values are given for individual radionuclides. For known mixtures of radionuclides, determine the sum of the ratio of the observed concentration of a particular radionuclide and its corresponding DAC for all radionuclides in the mixture. If this sum exceeds unity (1), then the DAC has been exceeded. For unknown radionuclides, the most restrictive DAC (lowest value) for those isotopes not known to be absent shall be used.

AIR IMMERSION DAC

| Radionuclide | Half-life | (μCi/mL) | (Bq/m$^3$) |
|---|---|---|---|
| Ar-37 | 35.02 d | 3E+00 | 1E+11 |
| Ar-39 | 269 yr | 1E–03 | 5E+07 |
| Ar-41 | 1.827 h | 3E–06 | 1E+05 |
| Kr-74 | 11.5 min | 3E–06 | 1E+05 |
| Kr-76 | 14.8 h | 1E–05 | 3E+05 |
| Kr-77 | 74.7 min | 4E–06 | 1E+05 |
| Kr-79 | 35.04 h | 1E–05 | 6E+05 |
| Kr-81 | 2.1E+05 yr | 7E–04 | 2E+07 |
| Kr-83m | 1.83 h | 7E–02 | 2E+09 |
| Kr-85 | 10.72 yr | 7E–04 | 2E+07 |
| Kr-85m | 4.48 h | 2E–05 | 1E+06 |
| Kr-87 | 76.3 min | 4E–06 | 1E+05 |
| Kr-88 | 2.84 h | 1E–06 | 7E+04 |
| Xe-120 | 40.0 min | 1E–05 | 4E+05 |
| Xe-121 | 40.1 min | 2E–06 | 8E+04 |
| Xe-122 | 20.1 h | 8E–05 | 3E+06 |
| Xe-123 | 2.14 h | 6E–06 | 2E+05 |
| Xe-125 | 16.8 h | 1E–05 | 6E+05 |
| Xe-127 | 36.406 d | 1E–05 | 6E+05 |
| Xe-129m | 8.89 d | 2E–04 | 7E+06 |
| Xe-131m | 11.84 d | 5E–04 | 1E+07 |
| Xe-133 | 5.245 d | 1E–04 | 5E+06 |
| Xe-133m | 2.19 d | 1E–04 | 5E+06 |
| Xe-135 | 9.11 h | 1E–05 | 6E+05 |
| Xe-135m | 15.36 min | 1E–05 | 3E+05 |

AIR IMMERSION DAC—Continued

| Radionuclide | Half-life | (μCi/mL) | (Bq/m$^3$) |
|---|---|---|---|
| Xe-138 | 14.13 min | 3E–06 | 1E+05 |

For any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life less than two hours, the DAC value shall be 6 E–06 μCi/mL (2 E+04 Bq/m$^3$).

[72 FR 31940, June 8, 2007, as amended at 76 FR 20489, Apr. 13, 2011]

## APPENDIX D TO PART 835—SURFACE CONTAMINATION VALUES

The data presented in appendix D are to be used in identifying the need for posting of contamination and high contamination areas in accordance with §835.603(e) and (f) and identifying the need for surface contamination monitoring and control in accordance with §§835.1101 and 835.1102.

SURFACE CONTAMINATION VALUES[1] IN DPM/100 CM$^2$

| Radionuclide | Removable[2 4] | Total (Fixed + Removable)[2 3] |
|---|---|---|
| U-nat, U-235, U-238, and associated decay products | [7]1,000 | [7]5,000 |
| Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129 | 20 | 500 |
| Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133 | 200 | 1,000 |
| Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above[5] | 1,000 | 5,000 |
| Tritium and STCs[6] | 10,000 | See Footnote 6 |

[1] The values in this appendix, with the exception noted in footnote 6 below, apply to radioactive contamination deposited on, but not incorporated into the interior or matrix of, the contaminated item. Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides apply independently.

[2] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[3] The levels may be averaged over one square meter provided the maximum surface activity in any area of 100 cm$^2$ is less than three times the value specified. For purposes of averaging, any square meter of surface shall be considered to be above the surface contamination value if: (1) From measurements of a representative number of sections it is determined that the average contamination level exceeds the applicable value; or (2) it is determined that the sum of the activity of all isolated spots or particles in any 100 cm$^2$ area exceeds three times the applicable value.

[4] The amount of removable radioactive material per 100 cm$^2$ of surface area should be determined by swiping the area with dry filter or soft absorbent paper, applying moderate pressure, and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. (Note—The use of dry material may not be appropriate for tritium.) When removable contamination on objects of surface area less than 100 cm$^2$ is determined, the activity per unit area shall be based on the actual area and the entire surface shall be wiped. It is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.

[5] This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90 which has been separated from the other fission products or mixtures where the Sr-90 has been enriched.

[6] Tritium contamination may diffuse into the volume or matrix of materials. Evaluation of surface contamination shall consider the extent to which such contamination may migrate to the surface in order to ensure the surface contamination value provided in this appendix is not exceeded. Once this contamination migrates to the surface, it may be removable, not fixed; therefore, a ''Total'' value does not apply. In certain cases, a ''Total'' value of 10,000 dpm/100 cm$^2$ may be applicable either to metals, of the types which form insoluble special tritium compounds that have been exposed to tritium; or to bulk materials to which particles of insoluble special tritium compound are fixed to a surface.

[7] These limits only apply to the alpha emitters within the respective decay series.

[58 FR 65485, Dec. 14, 1993, as amended at 63 FR 59688, Nov. 4, 1998; 72 FR 31940, June 8, 2007; 74 FR 18116, Apr. 21, 2009]